

---

# Contents

---

|  |            |
|--|------------|
| <b>Declaration</b>   | <b>ii</b>  |
| <b>Contents</b>  | <b>v</b>   |
| <b>List of Tables</b>  | <b>ix</b>  |
| <b>List of Figures</b>   | <b>x</b>   |
| <b>List of Abbreviations</b>   | <b>xiv</b> |
| <b>Abstract</b>  | <b>xvi</b> |
| <b>1 Introduction</b>  | <b>1</b>   |
| 1.1 An introduction about hoppers . . . . .                                      | 1          |
| 1.2 Traditional method of making hoppers . . . . .                               | 1          |
| 1.2.1 Most common ingredients of flour mixture . . . . .                         | 2          |
| 1.2.2 Basic method of making hoppers . . . . .                                   | 2          |
| 1.2.3 Different energy sources of making hoppers . . . . .                       | 3          |
| 1.3 Existing technology for making hoppers . . . . .                             | 3          |
| 1.4 Different types of hoppers . . . . .   | 4          |
| 1.4.1 Making plain hoppers . . . . .   | 4          |
| 1.4.2 Making egg hoppers . . . . .   | 5          |
| 1.4.3 Making milk hoppers . . . . .  | 5          |
| 1.5 Problems encountered in making hoppers by traditional methods . . . . .      | 6          |
| 1.5.1 Heat controlling of the cooking system . . . . .                           | 6          |
| 1.5.2 Keeping the individual attention on pans when using several pans . . . . . | 7          |
| 1.5.3 Applying oil or lubrication inside the pan . . . . .                       | 7          |

|          |   |           |
|----------|---|-----------|
| 1.5.4    | Spreading the flour mixture inside the pan . . . . .      | 8         |
| 1.5.5    | Removing cooked hoppers from the pan . . . . .            | 8         |
| 1.5.6    | Recipe of the flour mixture . . . . .                     | 8         |
| 1.5.7    | Qualitative properties of the pan . . . . .               | 8         |
| 1.5.8    | Duration of the cooking process . . . . .                 | 9         |
| 1.6      | Problems in commercial production . . . . .               | 9         |
| 1.6.1    | Insufficient supply to meet the demand . . . . .          | 10        |
| 1.6.2    | Lack of quality and freshness of cooked hoppers . . . . . | 10        |
| 1.6.3    | Higher labour cost of the production . . . . .            | 11        |
| 1.6.4    | Lifetime and crispness of cooked hoppers . . . . .        | 11        |
| 1.7      | Identification of areas for improvement . . . . .         | 11        |
| 1.7.1    | Spreading of flour mixture . . . . .                      | 12        |
| 1.7.2    | Weight and uniformity of hoppers . . . . .                | 12        |
| 1.7.3    | Heat control and wastage of cooking fuel . . . . .        | 13        |
| 1.7.4    | Wastage of raw materials . . . . .                        | 14        |
| 1.7.5    | Low efficiency . . . . .                                  | 15        |
| 1.7.6    | Production cost of hoppers . . . . .                      | 15        |
| <b>2</b> | <b>Design of the machine</b>                              | <b>16</b> |
| 2.1      | Design of the machine . . . . .                           | 16        |
| 2.1.1    | Frying Pan System (FPS) . . . . .                         | 17        |
| 2.1.2    | Frying Pan System Driving Unit (FPSDU) . . . . .          | 18        |
| 2.1.3    | Frying Pan System Controlling Unit (FPSCU) . . . . .      | 19        |
| 2.1.4    | Flour Mixture Flow Controller (FMFC) . . . . .            | 20        |
| 2.1.5    | Mixture Spreading System (MSS) . . . . .                  | 22        |
| 2.1.6    | Frying Pan Detecting Sensor (FPDS) . . . . .              | 23        |
| 2.1.7    | Electronic Controlling System (ECS) . . . . .             | 24        |
| 2.1.7.1  | 555 Timer IC . . . . .                                    | 24        |
| 2.1.8    | Burner System (BS) . . . . .                              | 28        |
| <b>3</b> | <b>Second Model of the Machine ...</b>                    | <b>30</b> |
| 3.1      | Frying Pan System Driving Unit (FPSDU) . . . . .          | 31        |
| 3.2      | Frying Pan System Controlling Unit (FPSCU) . . . . .      | 31        |

|          |  |           |
|----------|--|-----------|
| 3.2.1    | Principle of operation the IPS . . . . .                                     | 33        |
| 3.3      | Flour Mixture Flow Controller (FMFC) . . . . .                               | 34        |
| 3.4      | Mixture Spreading System (MSS) . . . . .                                     | 34        |
| 3.5      | Electronic Controlling System (ECS) . . . . .                                | 36        |
| <b>4</b> | <b>Low cost electronically improved machine</b>                              | <b>39</b> |
| 4.1      | Modification of the FMFC . . . . .   | 39        |
| 4.1.1    | A low cost automated device to release a certain volume of liquid . . . . .  | 44        |
| 4.1.2    | Methodology of the liquid measuring device . . . . .                         | 44        |
| 4.2      | Modification of the Mixture Spreading System (MSS) . . . . .                 | 49        |
| 4.3      | Modification of the ECS . . . . .  | 50        |
| 4.3.1    | Microcontroller program of the AECS . . . . .                                | 52        |
| 4.4      | Introducing the Pan Lid Detecting Sensor (PLDS) . . . . .                    | 58        |
| 4.5      | Semi Automated Hopper-Making Machine . . . . .                               | 60        |
| 4.5.1    | Making hoppers by the SAHMM . . . . .  | 61        |
| <b>5</b> | <b>Analysis</b>  | <b>62</b> |
| 5.1      | Flour mixture content of hoppers . . . . .                                   | 63        |
| 5.2      | Effect of adding eggs into the flour mixture . . . . .                       | 63        |
| 5.3      | Effect of adding sugar into the flour mixture . . . . .                      | 65        |
| 5.4      | Use of baking powder . . . . .   | 66        |
| 5.5      | Different methods of preparation of the flour mixture . . . . .              | 67        |
| 5.5.1    | Procedure for the preparation of flour mixture in the manual... . . . . .    | 67        |
| 5.5.2    | Procedure of preparation of the flour mixture in the mechanical... . . . . . | 68        |
| 5.6      | Analysis of the manual process of making hoppers . . . . .                   | 69        |
| 5.6.1    | Variation of gas consumption . . . . .                                       | 70        |
| 5.6.1.1  | Normalized variation of gas consumption... . . . . .                         | 71        |
| 5.6.2    | Variation of the number of hoppers produced from 1kg... . . . . .            | 72        |
| 5.6.2.1  | Normalized average number of hoppers... . . . . .                            | 72        |
| 5.6.3    | The average gas consumption for a single hopper . . . . .                    | 73        |
| 5.6.3.1  | Normalized average gas consumption... . . . . .                              | 74        |
| 5.6.4    | Gross weight of the mixture of 1kg of flour . . . . .                        | 75        |
| 5.6.5    | Average weight of a hopper . . . . .   | 76        |

|          |   |            |
|----------|---|------------|
| 5.6.6    | The time taken for making hoppers from 1kg of flour . . . . .             | 76         |
| 5.6.7    | Average cooking time of a hopper . . . . .                                | 77         |
| 5.7      | Analysis of the mechanical process of making hoppers . . . . .            | 79         |
| 5.7.1    | Gas consumption for 1kg of flour . . . . .                                | 79         |
| 5.7.2    | The time taken for making hoppers from 1kg of flour . . . . .             | 80         |
| 5.8      | Quality of hoppers made from the machine . . . . .                        | 80         |
| 5.9      | Comparison of the production efficiency of making hoppers... . . . .      | 81         |
| 5.10     | Comparison of cost analysis of making hoppers . . . . .                   | 81         |
| 5.11     | A simple device to reduce the wastage of cooking gas . . . . .            | 83         |
| 5.12     | Methodology . . . . .   | 83         |
| 5.12.1   | Optimum vertical gap between the burner and the cooking pan . . . . .     | 84         |
| <b>6</b> | <b>Conclusion and discussion</b>  | <b>89</b>  |
| 6.1      | Conclusion . . . . .  | 89         |
| 6.2      | Discussion . . . . .  | 91         |
| 6.2.1    | Important trouble shooting tips for making hoppers . . . . .              | 91         |
| 6.3      | Further improvements . . . . .  | 92         |
| 6.3.1    | Design an automated system for removing cooked hoppers ... . . . .        | 93         |
| 6.3.2    | Further improvement of FPDS . . . . .                                     | 93         |
| 6.3.3    | Further improvement of burner controlling system . . . . .                | 93         |
|          | <b>Bibliography</b>   | <b>94</b>  |
| <b>A</b> | <b>Drawings related to the Chapter 3</b>                                  | <b>98</b>  |
| <b>B</b> | <b>Awards and Certificates received for the invention</b>                 | <b>132</b> |
| B.1      | Sri Lankan patent certificate . . . . .                                   | 132        |
| B.2      | The University of Ruhuna Vice Chancellor's award ... . . . .              | 133        |
| B.3      | First place of presidential awards for the patented inventions... . . . . | 133        |
| B.4      | Third place at the 37 <sup>th</sup> International exhibitions ... . . . . | 133        |

---

# List of Tables

---

|      |  |     |
|------|--|-----|
| 3.1  | Specifications of the Inductive Proximity Sensor (PSO1)                | 32  |
| 5.1  | Statistical data form template   | 62  |
| 5.2  | The nutrient composition of the chicken egg                            | 64  |
| 5.3  | Collected data...  | 69  |
| 5.4  | Number of hoppers cooked per hour                                      | 78  |
| 5.5  | Measured data for 1kg of dry flour using the machine                   | 79  |
| 5.6  | Comparison of gas consumption between the manual and the mechanical... | 79  |
| 5.7  | Comparison of time taken for making hoppers...                         | 80  |
| 5.8  | Comparison of the number of hoppers produced from 1kg of flour with... | 81  |
| 5.9  | Cost analysis in the manual processes of making hoppers                | 82  |
| 5.10 | Cost analyze in the mechanical processes of making hoppers             | 82  |
| 5.11 | Comparison of experiments  | 87  |
| 5.12 | Time taken to reach the boiling point                                  | 88  |
| 6.1  | Estimated results for 1kg of dry flour in the manual process           | 90  |
| 6.2  | Estimated results for a single hopper in the manual process            | 90  |
| 6.3  | Estimated results for 1kg of dry flour in the machinery process        | 90  |
| 6.4  | Estimated results for a single hopper in the machinery process         | 90  |
| A.1  | Part list No.1   | 128 |
| A.2  | Part list No.2   | 129 |
| A.3  | Part list No.3   | 130 |
| A.4  | Part list No.4   | 131 |

---

# List of Figures

---

|      |   |    |
|------|---|----|
| 1.1  | Left:Cooked hoppers and Right:Frothy pulp . . . . .                   | 5  |
| 1.2  | Left:Well prepared flour mixture and Right:Making hoppers . . . . .   | 5  |
| 1.3  | Wastage of raw materials . . . . .                                    | 14 |
| 2.1  | Structure of the frying pan system . . . . .                          | 17 |
| 2.2  | Top view of the frying pan system . . . . .                           | 18 |
| 2.3  | Frying pan system driving unit . . . . .                              | 19 |
| 2.4  | Frying pan system controlling unit . . . . .                          | 19 |
| 2.5  | Flour mixture flow controller . . . . .                               | 20 |
| 2.6  | Valve controlling unit . . . . .                                      | 21 |
| 2.7  | Flour mixture container setup . . . . .                               | 22 |
| 2.8  | Flour mixture spreading system . . . . .                              | 23 |
| 2.9  | Frying pan detecting sensor . . . . .                                 | 24 |
| 2.10 | Schematic diagram of 555 . . . . .                                    | 25 |
| 2.11 | Astable mode timer circuit . . . . .                                  | 26 |
| 2.12 | Charging and discharging of the capacitor and output of 555 . . . . . | 26 |
| 2.13 | Functional type of 555 . . . . .                                      | 26 |
| 2.14 | Relay circuit of the AHMM . . . . .                                   | 28 |
| 2.15 | Burner system . . . . .   | 29 |
| 2.16 | Complete functional hopper-making machine (Model 1) . . . . .         | 29 |
| 3.1  | Inductive Proximity Sensor (PSO1) . . . . .                           | 32 |
| 3.2  | Main components of an IPS . . . . .                                   | 33 |
| 3.3  | Function of an IPS . . . . .  | 33 |
| 3.4  | Timer circuit with BD 137 Transistor . . . . .                        | 36 |

|      |   |    |
|------|---|----|
| 3.5  | Timer circuit with BD 138 Transistor . . . . .  | 36 |
| 3.6  | Relay circuit controlled by four timer circuits . . . . .                             | 37 |
| 3.7  | Second model of the machine . . . . .   | 38 |
| 4.1  | Filling process of trapping container . . . . .                                       | 40 |
| 4.2  | Releasing process of trapping container . . . . .                                     | 41 |
| 4.3  | Top view of the modified flour mixture flow controller . . . . .                      | 43 |
| 4.4  | Bottom view of the modified flour mixture flow controller . . . . .                   | 43 |
| 4.5  | The automated device . . . . .  | 45 |
| 4.6  | Filling the sub container when the solenoid is switched off . . . . .                 | 46 |
| 4.7  | Releasing the liquid when the solenoid is turned on . . . . .                         | 46 |
| 4.8  | Device controlling timer circuit . . . . .  | 48 |
| 4.9  | Distribution of measured data . . . . .   | 49 |
| 4.10 | Lever system . . . . .  | 50 |
| 4.11 | Microcontroller circuit . . . . .   | 51 |
| 4.12 | Power supply circuit . . . . .  | 52 |
| 4.13 | FDS and SDM module command flow charts . . . . .                                      | 55 |
| 4.14 | System command flow chart . . . . .   | 56 |
| 4.15 | Cup up and cup down module command flow charts . . . . .                              | 57 |
| 4.16 | MSM module flow chart . . . . .   | 57 |
| 4.17 | Schematic diagram of pan lid detecting sensor . . . . .                               | 58 |
| 4.18 | Pan lid detecting sensor . . . . .  | 59 |
| 4.19 | Top view of low cost electronically improved machine . . . . .                        | 59 |
| 4.20 | Semi automated hopper-making machine . . . . .  | 60 |
| 5.1  | The structural components of the egg . . . . .  | 64 |
| 5.2  | Variation of gas consumption with the operator for 1kg of flour... . . . .            | 70 |
| 5.3  | Normalized variation of gas consumption with the operator for 1kg of flour... . . . . | 71 |
| 5.4  | Variation of the number of hoppers with the operator from 1kg of flour... . . . .     | 72 |
| 5.5  | Normalized variation of number of hoppers produced from 1kg of dry flour... . . . .   | 73 |
| 5.6  | Variation of gas consumption with the operator for a single hopper . . . . .          | 74 |
| 5.7  | Variation of gas consumption with the operator for 1kg of flour... . . . .            | 74 |
| 5.8  | Variation of gross weight of the mixture from 1kg of flour . . . . .                  | 75 |

|      |   |     |
|------|---|-----|
| 5.9  | The average weight of a hopper . . . . .                          | 76  |
| 5.10 | Time taken for making hoppers from 1kg of flour . . . . .         | 77  |
| 5.11 | The average cooking time of a hopper . . . . .                    | 78  |
| 5.12 | Experimental setup . . . . .                                      | 84  |
| 5.13 | Comparison of the variation of temperature with time . . . . .    | 85  |
| 5.14 | Structure of the energy saving cooking device (Model 1) . . . . . | 85  |
| 5.15 | Comparison of the variation of temperature with time . . . . .    | 86  |
| 5.16 | Structure of the energy saving cooking device (Model 2) . . . . . | 87  |
| 6.1  | Cyclic process of a successful invention . . . . .                | 92  |
| A.1  | Part drawing 1 . . . . .  | 99  |
| A.2  | Sectional elevation of the second model of the machine . . . . .  | 100 |
| A.3  | Part drawing 1A . . . . .   | 101 |
| A.4  | Part drawing 1C . . . . .   | 102 |
| A.5  | Part drawings 1Ca, 1Cc, 1Da and 1Fa . . . . .                     | 103 |
| A.6  | Part drawings 1F and 1D . . . . .                                 | 104 |
| A.7  | Part drawings 1Fc, 1Fg, 1Fb and 1Fn . . . . .                     | 105 |
| A.8  | Part drawing 1G . . . . .   | 106 |
| A.9  | Part drawing 3 . . . . .  | 107 |
| A.10 | Part drawing 3A . . . . .   | 108 |
| A.11 | Part drawings 3F, 3B, 3K and 3H . . . . .                         | 109 |
| A.12 | Part drawing 5 . . . . .  | 110 |
| A.13 | Part drawings 5J, 5A, 5L, 5G and 5R . . . . .                     | 111 |
| A.14 | Part drawings 5C, 5H and 5Et . . . . .                            | 112 |
| A.15 | Part drawing 5E . . . . .   | 113 |
| A.16 | Part drawings 5Ep, 5Ed and 5Ea . . . . .                          | 114 |
| A.17 | Part drawings 5En, 5Ev, 5Ef, 5Ef and 5Er . . . . .                | 115 |
| A.18 | Part drawing 7 . . . . .  | 116 |
| A.19 | Part drawing 7A . . . . .   | 117 |
| A.20 | Part drawings 7D and 7B . . . . .                                 | 118 |
| A.21 | Part drawing 9 . . . . .  | 119 |
| A.22 | Part drawings 9B, 9F, 9H and 9T . . . . .                         | 120 |

|  |     |
|--|-----|
| A.23 Part drawing 9E . . . . .   | 121 |
| A.24 Part drawings 9J, 9S, 9R and 9N . . . . .   | 122 |
| A.25 Part drawing 9M . . . . .   | 123 |
| A.26 Part drawings 9Ea, 9Mh, 9Eb, 9Me and 9Ed . . . . .  | 124 |
| A.27 Panel board . . . . .   | 125 |
| A.28 Control switch diagram . . . . .  | 126 |
| A.29 Aluminium frying pan . . . . .  | 127 |
| <br>   |     |
| B.1 Page-1: Sri Lankan Patent of the AHMM . . . . .  | 134 |
| B.2 Page-2: Sri Lankan Patent of the AHMM . . . . .  | 135 |
| B.3 Page-1: Agreement between IDB . . . . .  | 136 |
| B.4 Page-2: Agreement between IDB . . . . .  | 137 |
| B.5 IDB manufacturing automated hopper-making machines in Matara branch . . . . .                    | 138 |
| B.6 Certificate offered for the Vice Chancellor's award... . . . . .                                 | 139 |
| B.7 Trophy received for the Vice Chancellor's award... . . . . .                                     | 139 |
| B.8 Certificate offered for the first place of presidential awards... . . . . .                      | 140 |
| B.9 Trophy received for the first place of presidential awards... . . . . .                          | 141 |
| B.10 Gold medal received for the first place of presidential awards... . . . . .                     | 141 |
| B.11 Certificate offered in the 37 <sup>th</sup> International Exhibition held in Geneva . . . . .   | 142 |
| B.12 Bronze medal received in the 37 <sup>th</sup> International Exhibition held in Geneva . . . . . | 143 |